(1) Discussion of the thunderstorms (*orages*) of these years, illustrated with forty-six maps. (2) Hailstorms, with three maps. This part of the work, which is of so much importance to agriculture, has been unfortunately neglected for some time, but is now to be vigorously prosecuted. (3) Report on the climatic observations made in France, and particularly on the distribution of rain, with four maps. (4) Meteorological memoirs and documents (thirteen in all), contributed by different meteorologists of France and other countries, a section of the work which is expected to receive a fuller development in future issues.*

A noteworthy feature of the publication consists in the fact that the materials which make it up have been collected under the auspices of the Departmental Commissions, and in great part discussed by them. This is, particularly for such a country as France, an admirable arrangement, since there is no European country the working out of the meteorology of which presents a more complex problem, owing to the great diversity of the climates of its different regions; and further, the agricultural interests of no other country would benefit more than those of France, were a correct knowledge of its climate generally disseminated among the people. Now, this feature of the publication gives the local colouring to the reports which is fitted to arrest general attention and secure the putting forth of those local efforts by which alone the meteorology of France can be satisfactorily worked out.

It may be here pointed out that the French meteorological organisation is based on the Commissions which have been appointed in each of the departments; it being to them that the Government, in the decree of Feb. 13, 1873, has remitted the working out of the meteorology of the different river-basins, and inquiries connected therewith. They are invited to unite together for certain objects into Regional Commissions, for the purpose of imparting to their investigations greater breadth and exactness. They are not put under the Central Administration at Paris in the sense of being controlled by it, but are connected with it in order that they may be aided by it in cases where aid is needed. The Departmental Commissions have free automatic action in working out the problem of the local climates of the respective districts which have been entrusted to them.

The programme assigned to the Central Observatory of Paris, consisting of the investigation of the great movements of the atmosphere, and meteorological warnings for the seaports and for agriculture, is too limited in its scope; and we cannot suppose that its illustrious head will be satisfied till he has succeeded in including in the regular work of the Observatory those physical researches we have already strongly advocated in NATURE (vol. x. p. 99) as an indispensable part of the work to be undertaken by the Central Meteorological Office of each country, and which have been more recently and ably stated by Prof. Balfour Stewart and Col. Strange (pp. 476 and 490).

In the same article we urged the necessity of the State and the country working together; indeed, in no other way is it possible successfully to work out the great national questions of storms and of local climates in their bearings on the health, productions, and commerce of the country. In France we see that this essential requisite, of the State and the country working together, has been effected, and it may not be irrelevant to add that the French Government has clearly recognised the position that unaided voluntary efforts are insufficient of themselves to cope with the subject, and that if the undertaking is to be conducted in a manner worthy of the nation and of the ends to be subserved by it, it must be supported with aid from the public funds.

---

*MAREY'S "ANIMAL MECHANISM"**

Animal Mechanism. By E. J. Marey. "The International Scientific Series." (London: Henry S. King and Co., 1874.)

II.

In his treatment of aërial locomotion, Prof. Marey has been even more successful than in his investigations with regard to progression on land. Nearly two centuries ago the general principles of this subject were very ably worked out by Borelli, who, after having shown that in the wing the anterior margin is rigid whilst the posterior portions are more and more flexible as they go backwards, inferred, as will be self-evident to all, that in the downward stroke of the flying bird the plane of the wing becomes directed downwards and backwards on account of the hinder margin yielding slightly to the resisting air. It not having struck him that the wing was elastic in its horizontal as well as its vertical direction, Borelli assumed that the stroke was strictly vertical.

By a series of experiments, the logical sequence and convincing power of which are perhaps unequalled in any other extant biological problem, Prof. Marey has been able to demonstrate the effects of the horizontal yieldingness of the wing, and to prove that in insects the stroke, instead of being, as Borelli assumed, a simple vertical line, is a vertical figure of 8. In proof of this original and, at first sight, unexpected observation, he shows that if the tip of the wing of a wasp be gilt, and the insect allowed to buzz in a beam of sunlight, a very elongated vertical figure of 8 image is seen, as in Fig. 1, to be produced by the reflecting tip of the rapidly moving wing; "sometimes, indeed, the wing seems to move entirely in one plane, and the instant afterwards the terminal loops which form the 8 are seen to open more and more. When the opening is very large, one of the loops usually predominates over the other; it is generally the lower one which increases, while the upper diminishes. Indeed, by a still greater opening, the figure is occasionally transformed into an irregular ellipse, at the extremity of which we can recognise a vestige of the second loop."

There is still more to be learnt from this simple experiment. By carefully gilding one surface of the wing alone, the buzzing wing, when intensely illuminated, exhibits the figure of 8 of unequal intensity in its two moieties, as seen in Fig. 1; so that it resembles the figure printed thus, **8**, if its thick part be considered to represent that which is most illuminated, and its thin part the darker half. This result can only be produced by the plane of the wing being different in the up and down strokes ; and, as is found to be the case, the thick limb is reversed by turning the insect round so that it presents its other side to the observer. The same conclusion is arrived at by the employment of the method to be now described.

---

* The price of the volume, post-free to England, is, we understand, 10s. (12 fr.)

* Continued from p. 500.

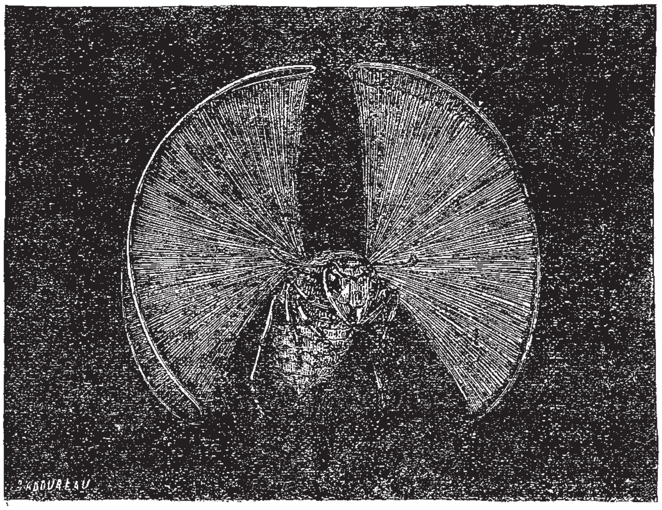

FIG. 1.

Without sensibly interfering with the movement of the wing, its tip may be made to come in contact with a revolving cylinder, in which the surface is covered with smoked paper. "Although the figures thus produced are for the most part incomplete, we are able, by means of their scattered elements, to reconstruct the figure which has been shown by the optical method." Fig. 2 is one of the results obtained, in which several of the loops are distinctly seen, as is generally the case when, as here, the insect is so held as to rub the cylinder with the hinder edge of the tip of the wing. That a figure of 8 movement of a point, when made to record on a revolving drum, produces a similar curve, is seen from Fig. 3, which is a tracing of a Wheatstone's kaleidophone rod, tuned to the octave, or, in other words, vibrating twice transversely for each longitudinal vibration.

Still we are not able to say in which direction the wing is moving in the different branches of the 8 figure ; the following simple experiment determines this completely. A slender glass rod is smoked at the tip in the flame of a candle, and held at right angles to the direction in which the wing moves, in the different parts of the wing-tip tract, as in Fig. 4. It is evident that if the wing hits the rod whilst it is descending, it will rub off the smoke film from its upper, and whilst ascending, from its lower surface. Supposing that, in the figure, the head of the insect is directed to the right: when the glass rod enters the loops at *b'* and *a* it is found to strike the upper surface; when at *b* and *a'*, the lower; consequently the arrows indicate the true direction of the wing's motion.

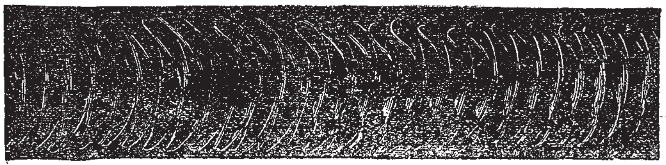

FIG. 2.

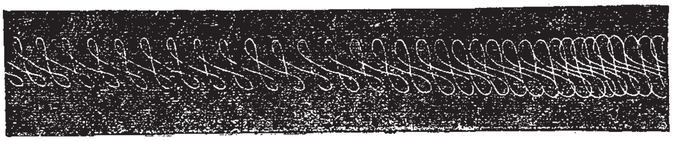

FIG. 3.

The foregoing facts, when taken in connection with their known anatomical arrangements, place us in a position to discuss the mechanism of the flight of insects. These animals possess muscles, &c., which produce direct downward and upward movements of the wings, and these movements only ; therefore the expansion of this vertical line into a figure of 8 must be caused by forces acting external to the thoracic or wing-moving mechanism ; in other words, by peculiarities in the structure of the wings themselves. Simple inspection of the wing of a fly shows it to be formed of a rigid, or comparatively rigid, anterior nervure, which supports a thin more yielding membrane behind it. In its descent, the resistance of the air retards the movement of the more yielding posterior portion of the wing sufficiently to cause the lower surface of its otherwise horizontal plane to become directed slightly backwards, and in its ascent the same cause directs it somewhat forward. But an inclined plane striking the air has a tendency to move in the direction of its own inclination; consequently, both in the down and up stroke of the wing, it tends to move forward at the same time. "But this deviation cannot be effected without the nervure being slightly bent. The force which causes the wing to deviate in a forward direction necessarily varies in intensity according to the rapidity with which the organ is depressed. Thus, when the wing towards the end of its descending course moves more slowly, we shall see the nervure, as it is bent with less force, bring the wing backwards in a curvilinear direction. Thus we explain naturally the formation of the descending branch of the 8 passed through by the wing;" and the same theory applies to the ascending branch of the figure.

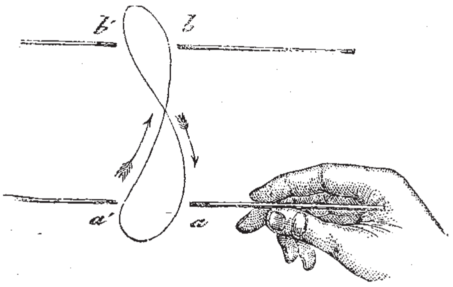

Fig. 4.

Acting upon the suggestions of his theory, Prof. Marey has constructed artificial wings, which are planned and move upon the same principle as those of insects. He has not succeeded in making a flying machine, it is true; this, however, is not from any fault in the wings, but because it is impossible to obtain an engine sufficiently light to drive them. He has, however, contrived an apparatus which, when the motor power is supported, is capable of moving horizontally with rapidity, of rising and of falling, just like an insect; and, what is more, when propelled by a simple up and down movement, the tips of the wings describe a figure of 8 of their own accord, as they ought to do upon the theory which led to their construction.

The mechanism of the flight of birds is a problem far more difficult to master than that of insects. The size of the subjects of experiment, and the comparative slowness of the movements of their wings, remove them beyond the reach of the optical and direct graphic method previously employed. Each stroke of the wing has to be recorded through the intervention of a complicated system of tubes and levers, as fragile as they are delicate, and as expensive, as they are liable to be broken. Movements in a single plane are capable of being transferred to paper with comparative ease, but when they are not so limited, and may be in any direction, the necessary complication of the recording machinery becomes immense. The number of little details which have to be continually remembered, and the oft-repeated futile attempts which have to be allowed for, makes Prof. Marey's success in his investigations a matter of more than ordinary surprise. He has mastered the whole subject, having by separate and by combined check methods demonstrated what is the rapidity, direction, and inclination of the wing of the bird in every part of its course. Further than this, he has shown what effects the stroke has on the movements of the body of the bird, and this by a very ingenious new method. The way in which the author invents means for reproducing and originating any quality of movement he may want to develop, must be a source of admiration and almost astonishment to all readers of his work.

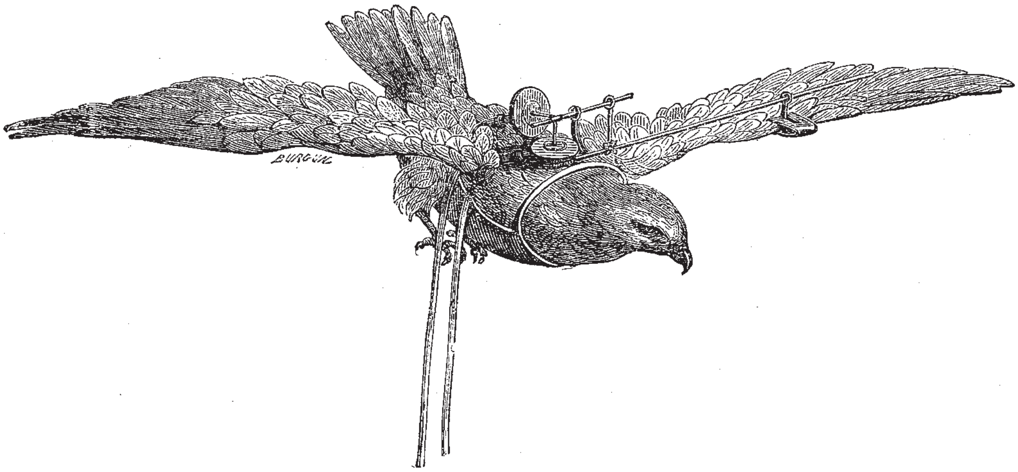

Fig. 5.

Fig. 5 shows a buzzard saddled with the machinery which, by means of the two tubes running downwards from it, transmits the vertical and horizontal movements of its wing to the recording apparatus, which is not represented. In the study of the more intricate points the necessary instruments are so heavy that the whole bird has to be partially supported. This is done by attaching it to the extremity of a long lever which revolves, with scarcely any friction, on a pivot. This is found not seriously to interfere with the normal flight of the bird.

Most of the facts made out by the employment of this apparatus are shown in Fig. 6, which is constructed to illustrate the inclination of the plane of the wing with reference to the axis (*Av*) of the body of the bird during flight. The direction of the movement of the wing is from *H* to *Av*. It shows "that the wing during its ascent assumes an inclined position, which allows it to cut the air so as to meet with the minimum of resistance; while in its descent, on the contrary, the position of its plane is reversed, so that its lower surface turns downwards and slightly backwards." During the descent of the wing the body of the bird is carried forwards as well as upwards. The resistance of the air explains the elliptical form of the figure.

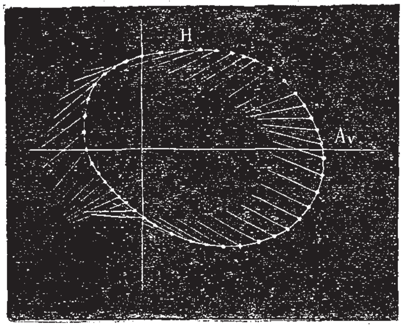

Fig. 6.

We hope that in the short glance which we have taken of some of the most important points discussed in the work before us, we have succeeded in interesting our readers sufficiently in its contents to make them curious to learn more of its subject matter. We cordially recommend it to their attention. To the student of art it gives rules and general principles which will be found invaluable in all attempts to portray the various attitudes of man and his faithful companion, the horse; and these, when understood, will direct attention to the most salient points in the locomotion of other animals.

To the student of physiology it is useful in at least two ways. It shows how invaluable is a knowledge of manipulatory details and the principles of mechanics. Prof. Marey, in the period of his studentship, must have learnt more than the simple routine facts of a medical education. The mechanical Cardan universal joint and Wheatstone's kaleidophone rod are as familiar to him as is the valvular mechanism of the heart; it is his control of method which is one of his most marked characteristics. It shows how elaborate are some of the phenomena which at first sight seem so simple, and how much the science of physiology is within the domain of physics.

The translation, as far as we have had the opportunity of judging, seems a good one, except in one or two cases, where improvement would not be impossible.

OUR BOOK SHELF

The Protoplasmic Theory of Life. By John Drysdale, M.D. (Baillière, Tyndall, and Cox, 1874.)

THE author of this small book is one of the editors of a work on Pathology, by Dr. John Fletcher, of Edinburgh, whose "Rudiments of Physiology" contains much speculative biology of no mean quality. As a disciple he enters into an analysis of the philosophy of his master, discussing its details in connection with the light thrown upon it by modern research, especially the bioplasm theory of Beale. Fletcher argued thus:—The peculiar property, vitality, does not reside in the tissues of the living body indiscriminately, but in one anatomical element alone; because, as the various tissues differ extremely in their physical properties, and these latter are almost exactly the same after as before death, it is hardly to be expected that the living matter can rearrange itself on death, in a short time, into a number of different forms, which shall possess exactly the same physical properties in the vital as in the ordinary state of combination. The concordance of this idea with the theory of Dr. Beale, which divides all tissues into a living forming material (bioplasm), and a dead formed material, the composition of the latter of which alone varies to any extent, must be evident to all; and the working out of its minutiæ occupies several chapters of the work before us. The author also enters fully into the muscle and nerve theory of Dr. Beale in a manner which we do not think will throw much light on either subject. He remarks that the insulating power of the medullary sheath of the nerve-fibre is not demonstrable, therefore "the nerves are not fitted for simple conduction of electric currents; and these have no reason to choose the nerves as their channels, so they spread through the moist tissues almost uniformly." With this opinion we think there are few or no physiologists who will agree, as there is not the least doubt that it is through nerve-fibres that electric stimulation will most readily and most powerfully affect muscular fibres at a distance; otherwise, what is the peculiar value of the "nerve-muscle preparation" of the physiological laboratory? In his remark that Dr. Sanderson is premature in arguing with regard to the Dionæa "that because the contraction of the plant-leaf depends on changes, apparently in the contents of the cells, the muscular contraction of the higher animals is of the same nature," the author is, we think, more fortunate; we have never been able to see that the two phenomena have anything in common. From the consideration of the less speculative protoplasmic theory of the origin of tissues, such points as the nature of life, the connection of force with life and mind, consciousness, and materialism, subjects beyond the pale of precise knowledge, are treated of in a manner which will quite repay perusal by those who are fond of speculating on those precarious topics.

Out of Doors: a Selection of Original Articles on Practical Natural History. By the Rev. J. G. Wood, M.A., F.L.S. (London: Longmans and Co., 1874.)

MR. WOOD is well known as one of the most successful popularisers of natural history. He has himself an extensive and thorough knowledge of his subject, as well as a genuine love of it, and his genial enthusiasm cannot fail to infect the minds of the fortunate boys and girls into whose hands his books may fall. The present volume consists of a number of thoroughly readable papers which have already appeared in various periodicals. They are written in an easy, graceful, chatty style; and while apparently trying only to amuse his readers, he manages to convey a great deal of valuable information about animals and plants, especially about such as anyone who likes to take the trouble may observe for himself. Some of the papers are concerned with exotic animals, as in that describing "A January Day at Regent's Park," in which are contained many facts concerning the inhabitants of the Zoological Gardens. Most of them are, however, about the "common objects of the country," as is indicated by such titles as "A Sand Quarry in Winter," "Under the Bark," "My Toads," "The Children of the New Forest," "The Repose of Nature," the last concerned with hybernating animals. In "Medusa and her Locks," and "Life on the Ocean Wave" (describing a visit to the Crystal Palace Aquarium), "The Green Crab," &c., we are introduced to the denizens of the ocean. The book is an excellent one to give to a boy or a girl, who, we are sure, would enjoy it, as indeed would many whose boyhood or girlhood is only a sad memory.